Remarks

The Office Action mailed February 25, 2004 has been carefully reviewed and the foregoing amendment has been made in consequence thereof.

Claims 2-3, 5-11, 13-17, 19-25, and 27-37 are now pending in this application. Claims 2, 3, 7, 10, 11, 15-17, 19, 21, 24, 25, and 31 have been amended. Claims 36-37 have been newly added. No new matter has been added. Claims 2-3, 5-11, 13-17, 19-25, and 27-31 stand rejected. Claims 32-35 are objected to.

The objection to the drawings is respectfully traversed. Applicants herewith amend the drawings. Accordingly, Applicants respectfully request that the objection to the drawings be withdrawn.

The objection to Claims 13-14 and 19-20 is respectfully traversed. Applicants herewith amend Claim 19. Accordingly, Applicants respectfully request that the objection to Claims 13-14 and 19-20 be withdrawn.

The rejection of Claims 2-3, 5-11, 13-17, 19-25, and 27-35 under 35 U.S.C. § 112, second paragraph, is respectfully traversed. Applicants herewith amend Claims 2, 3, 7, 10, 15-17, 21, 24, and 31. Applicants respectfully submit that Claims 2-3, 5-11, 13-17, 19-25, and 27-35 particularly point out and distinctly claim the subject matter which the Applicants regard as their invention. Accordingly, Applicants respectfully request that the rejection to Claims 2-3, 5-11, 13-17, 19-25, and 27-35 under 35 U.S.C. § 112, second paragraph be withdrawn.

The rejection of Claims 2-3, 7, 15-17, 21, and 31 under 35 U.S.C. § 103 as being unpatentable over Smith (U.S. Pat. No. 5,570,310) in view of Watson (U.S. Pat. No. 5,629,780) is respectfully traversed.

Smith describes a mathematical theory and a computation of a logarithm by a data processor (column 3, line 31, column 6, lines 20-21). The mathematical theory is used to

compute a logarithm to a base p of a floating-point number x (column 3, lines 32-34). The correctness of the computation of the logarithm is validated by a mathematical identity $\log_p(x) = \log_p(2^k y) = (k+c_i)\log_p(2) - \log_p(b_i) + \log_p(1+(a_i y-1))$, which is valid for quantities a_i, b_i, and c_i, satisfying the relationship $b_i = 2^{c_i} a_i$ (column 3, lines 37-46). The computation of $\log_p(1+(a_i y-1))$ is carried out using a polynomial approximation $\log_p(1+(a_i y-1)) \approx (a_i y-1)$ (column 3, lines 46-50). In step (10), the processor reads from some memory region an instruction which causes the logarithm of an argument x to be evaluated (column 6, lines 21-23). In step (20), the processor reads from some memory region the argument x whose logarithm to some numerical base is to be computed (column 6, lines 23-25). The argument may represent a particular numeric value, infinity, or Not a Number (NaN) (column 6, lines 25-27). Whether the argument represents a particular numeric value or not, it may or may not have a logarithm which can be represented by a real number (column 6, lines 27-30). Step (30) constructs a number y from the argument x such that if x represents a normalized numerical value, then $x = \pm 2^k y$ with $1 \leq y < 2$ (column 6, lines 30-32). If x does not represent a numeric value, y still represents a numeric value which can be used in arithmetic operations without causing any exceptions, which can enhance speed and performance by not having to check initially for special conditions (column 6, lines 32-37). The early generation of a valid y provides a very fast route for computing the logarithm in almost all cases normally encountered (column 6, lines 37-38). The additional processing required for a denormalized numeric argument is illustrated in FIG. 2 (column 6, lines 38-40). Step (40) uses the bit representation of the argument x or of the number y as a basis for reading from memory a predetermined quantity a (column 6, lines 41-44). An efficient way of determining which predetermined quantity a is to be read is described in FIG. 3 (column 6, lines 44-46). Step (50) determines whether the logarithm of the argument x exists or not (column 6, lines 47-48). If it does, it returns a close approximation to the logarithm obtained by evaluating $\log(y)=-\log(a)+\log(1+(ay-1))$ and $\log(x)=k\log(2)+\log(y)$ in step 60 (column 6, lines 48-50). The details of one way in which this can be performed will be described by FIG. 3 (column 6, lines 50-52). If the logarithm of the argument does not exist, a return path which provides further information is performed in step (70) (column 6, lines 52-54). An efficient way of

returning this further information in one environment is described in further detail in FIG. 4 (column 6, lines 54-56).

Watson describes a method for performing color or grayscale image compression using a Discrete Cosine Transform (DCT) (Abstract). In the method, a digital grayscale or color image is transformed into a compressed digital representation of that image (column 3, lines 55-56). The method includes the steps of transforming each color pixel, if necessary, into brightness and color channel values, down-sampling, if necessary, each color channel, partitioning each color channel into square blocks of contiguous pixels, applying a Discrete Cosine Transform (DCT) to each block in each color channel, selecting a DCT mask ($m_{u,v,b,\theta}$) for each block of pixels in each color channel, and selecting a quantization matrix ($q_{u,v,\theta}$) for quantizing DCT transformation coefficients ($c_{u,v,b,\theta}$) produced by the DCT transformation (column 3, lines 55-66). In the method, a storage mode (16) is segmented into the following steps: color transform (31), down-sample (32), block (33), DCT (34), initial matrices (35), quantization matrix optimizer (36), quantize (38), and entropy code (40) (column 5, line 67 – column 6, line 4). After the calculation of a DCT mask (70) has been determined, an iterative process of estimating the quantization matrix operator (36) begins and includes processing segments (56, 58, 60, 62, 64, and 66) (column 9, lines 8-11). The quantization matrix optimizer transforms each block of the image in an initial matrix (35) into segments (56). A bisection method is then used to increment or decrement the initial matrices. In the bisection method, a range is established for $q_{u,v,\theta}$ between lower and upper bounds, typically 1 to 255 (column 10, lines 28-30). A perceptual error matrix $p_{u,v,\theta}$ is evaluated at midpoint of the range (column 10, lines 30-32). If $p_{u,v,\theta}$ is greater than a target error parameter, then the lower bound is reset to the mid-point (column 10, lines 32-34).

Claim 15 recites a computing device including a memory in which binary floating point representations of particular numbers are stored, the device being configured to "partition a mantissa region between 1 and 2 into N equally spaced sub-regions; precompute a reference point a_i of each of the N equally spaced sub-regions, where $i=0,\ldots,N-1$, wherein N is sufficiently large so that, within each sub-region, a first degree polynomial in m computes

log(m) to within a preselected degree of accuracy for any m within the sub-region, where m is a mantissa of a binary floating point representation of a variable x; compute a value of log(x) for a binary floating point representation of x stored in said memory utilizing the first degree polynomial in the binary mantissa m, wherein log(x) is a function of a distance between the reference point a_i and the binary mantissa m; and generate an image by using the computed value of log(x)."

Neither Smith nor Watson, considered alone or in combination, describe or suggest a computing device including a memory in which binary floating point representations of particular numbers are stored, the device being configured to partition a mantissa region between 1 and 2 into N equally spaced sub-regions, precompute a reference point a_i of each of the N equally spaced sub-regions, where $i=0,...,N-1$, where N is sufficiently large so that, within each sub-region, a first degree polynomial in m computes log(m) to within a preselected degree of accuracy for any m within the sub-region, where m is a mantissa of a binary floating point representation of a variable x, compute a value of log(x) for a binary floating point representation of x stored in said memory utilizing the first degree polynomial in the binary mantissa m, where log(x) is a function of a distance between the reference point a_i and the binary mantissa m, and generate an image by using the computed value of log(x).

Moreover, neither Smith nor Watson, considered alone or in combination, describe or suggest a computing device configured to compute a value of log(x) for a binary floating point representation of x stored in said memory utilizing the first degree polynomial in the binary mantissa m, where log(x) is a function of a distance between the reference point a_i and the binary mantissa m. Rather, Smith describes that a close approximation to the logarithm is obtained by evaluating $\log(y)=-\log(a)+\log(1+(ay-1))$, that $\log(x)=k\log(2)+\log(y)$ and that mathematical identity $\log_p(x) = \log_p(2^k y) = (k+c_i)\log_p(2) - \log_p(b_i) + \log_p(1+(a_i y-1))$. Watson describes a method that includes the steps of transforming each color pixel, if necessary, into brightness and color channel values, down-sampling, if necessary, each color channel, partitioning each color channel into square blocks of contiguous pixels, applying a Discrete Cosine Transform (DCT) to each block in each color channel, selecting a DCT mask ($m_{u,v,b,\theta}$)

for each block of pixels in each color channel, and selecting a quantization matrix ($q_{u,v,\theta}$) for quantizing DCT transformation coefficients ($c_{u,v,b,\theta}$) produced by the DCT transformation. Watson also describes that a bisection method is used to increment or decrement a matrix, where the bisection method includes establishing a range for $q_{u,v,\theta}$ between lower and upper bounds, typically 1 to 255, a perceptual error matrix $p_{u,v,\theta}$ is then evaluated at midpoint of the range. For the reasons set forth above, Claim 15 is submitted to be patentable over Smith in view of Watson.

Claims 16, 17, and 21 depend, directly or indirectly, from independent Claim 15. When the recitations of Claims 16, 17, and 21 are considered in combination with the recitations of Claim 15, Applicants submit that dependent Claims 16, 17, and 21 likewise are patentable over Smith in view of Watson.

Claim 31 recites a method for computing an approximation of a natural logarithm function including the steps of "partitioning a mantissa region between 1 and 2 into N equally spaced sub-regions; precomputing a reference point a_i of each of the N equally spaced sub-regions, where $i = 0,\ldots,N-1$; selecting N sufficiently large so that, for each sub-region, a first degree polynomial in m computes $\log(m)$ to within a preselected degree of accuracy for any m within the sub-region, where m is a binary mantissa of a binary floating point representation of a variable x; computing a value of $\log(x)$ for a binary floating point representation of x stored in a memory of a computing device utilizing the first degree polynomial in the binary mantissa m, wherein $\log(x)$ is a function of a distance between the reference point a_i and the binary mantissa m; and generating an image by using the computed value of $\log(x)$." repeat

Neither Smith nor Watson, considered alone or in combination, describe or suggest a method for computing an approximation of a natural logarithm function including the steps of partitioning a mantissa region between 1 and 2 into N equally spaced sub-regions, precomputing a reference point a_i of each of the N equally spaced sub-regions, where

$i=0,\ldots,N-1$, selecting N sufficiently large so that, for each sub-region, a first degree polynomial in m computes $\log(m)$ to within a preselected degree of accuracy for any m within the sub-region, where m is a binary mantissa of a binary floating point representation of a variable x; computing a value of $\log(x)$ for a binary floating point representation of x stored in a memory of a computing device utilizing the first degree polynomial in the binary mantissa m, where $\log(x)$ is a function of a distance between the reference point a_i and the binary mantissa m, and generating an image by using the computed value of $\log(x)$.

Moreover, neither Smith nor Watson, considered alone or in combination, describe or suggest a method including computing a value of $\log(x)$ for a binary floating point representation of x stored in a memory of a computing device utilizing the first degree polynomial in the binary mantissa m, where $\log(x)$ is a function of a distance between the reference point a_i and the binary mantissa m. Rather, Smith describes that a close approximation to the logarithm is obtained by evaluating $\log(y)=-\log(a)+\log(1+(ay-1))$, that $\log(x)=k\log(2)+\log(y)$ and that mathematical identity $\log_p(x) = \log_p(2^k y) = (k+c_i)\log_p(2) - \log_p(b_i) + \log_p(1+(a_i y-1))$. Watson describes a method that includes the steps of transforming each color pixel, if necessary, into brightness and color channel values, down-sampling, if necessary, each color channel, partitioning each color channel into square blocks of contiguous pixels, applying a Discrete Cosine Transform (DCT) to each block in each color channel, selecting a DCT mask ($m_{u,v,b,\theta}$) for each block of pixels in each color channel, and selecting a quantization matrix ($q_{u,v,\theta}$) for quantizing DCT transformation coefficients ($c_{u,v,b,\theta}$) produced by the DCT transformation. Watson also describes that a bisection method is used to increment or decrement a matrix, where the bisection method includes establishing a range for $q_{u,v,\theta}$ between lower and upper bounds, typically 1 to 255, a perceptual error matrix $p_{u,v,\theta}$ is then evaluated at midpoint of the range. For the reasons set forth above, Claim 31 is submitted to be patentable over Smith in view of Watson.

Claims 2, 3, and 7 depend, directly or indirectly, from independent Claim 31. When the recitations of Claims 2, 3, and 7 are considered in combination with the recitations of

Claim 31, Applicants submit that dependent Claims 2, 3, and 7 likewise are patentable over Smith in view of Watson.

For the reasons set forth above, Applicants respectfully request that the Section 103 rejections of Claims 2-3, 7, 15-17, 21, and 31 be withdrawn.

The rejection of Claims 8-11, 22-25, and 29-30 under 35 U.S.C. § 103 as being unpatentable over Smith in view of Watson and further in view of Wallschlaeger (U.S. Pat. No. 5,345,381) is respectfully traversed.

Smith and Watson are described above. Wallschlaeger describes a spiral scan computer tomography apparatus with improved image quality in comparison to conventional systems (column 1, lines 50-53). For systems using a spiral scan, interpolation algorithms have been developed which generate new data, by interpolation, corresponding to a planar slice from the spiral data before the actual image reconstruction (column 1, lines 29-33). Interpolation algorithms are then used on the spiral data in the form of attenuation values (column 1, lines 36-38). The attenuation values are scaled line integrals or scaled logarithms of the relative intensities (column 1, lines 38-39).

Claims 22-25 and 30 depend, directly or indirectly, from independent Claim 15 which recites a computing device including a memory in which binary floating point representations of particular numbers are stored, the device being configured to "partition a mantissa region between 1 and 2 into N equally spaced sub-regions; precompute a reference point a_i of each of the N equally spaced sub-regions, where $i=0,\ldots,N-1$, wherein N is sufficiently large so that, within each sub-region, a first degree polynomial in m computes $\log(m)$ to within a preselected degree of accuracy for any m within the sub-region, where m is a mantissa of a binary floating point representation of a variable x; compute a value of $\log(x)$ for a binary floating point representation of x stored in said memory utilizing the first degree polynomial in the binary mantissa m, wherein $\log(x)$ is a function of a distance between the reference point a_i and the binary mantissa m; and generate an image by using the computed value of $\log(x)$."

None of Smith, Watson, and Wallschlaeger, considered alone or in combination, describe or suggest a computing device including a memory in which binary floating point representations of particular numbers are stored, the device being configured to partition a mantissa region between 1 and 2 into *N* equally spaced sub-regions, precompute a reference point a_i of each of the *N* equally spaced sub-regions, where $i=0,\ldots,N-1$, where *N* is sufficiently large so that, within each sub-region, a first degree polynomial in *m* computes log(*m*) to within a preselected degree of accuracy for any *m* within the sub-region, where *m* is a mantissa of a binary floating point representation of a variable *x*, compute a value of log(*x*) for a binary floating point representation of *x* stored in said memory utilizing the first degree polynomial in the binary mantissa *m*, where log(*x*) is a function of a distance between the reference point a_i and the binary mantissa *m*, and generate an image by using the computed value of log(*x*).

repeat,

Moreover, none of Smith, Watson, and Wallschlaeger, considered alone or in combination, describe or suggest a computing device configured to compute a value of log(*x*) for a binary floating point representation of *x* stored in said memory utilizing the first degree polynomial in the binary mantissa *m*, where log(*x*) is a function of a distance between the reference point a_i and the binary mantissa *m*. Rather, Smith describes that a close approximation to the logarithm is obtained by evaluating log(y)=-log(a)+log(1+(ay-1)), that log(x)=klog(2)+log(y) and that mathematical identity $\log_p(x) = \log_p(2^k y) = (k+c_i)\log_p(2) - \log_p(b_i) + \log_p(1+(a_i y-1))$. Watson describes a method that includes the steps of transforming each color pixel, if necessary, into brightness and color channel values, down-sampling, if necessary, each color channel, partitioning each color channel into square blocks of contiguous pixels, applying a Discrete Cosine Transform (DCT) to each block in each color channel, selecting a DCT mask ($m_{u,v,b,\theta}$) for each block of pixels in each color channel, and selecting a quantization matrix ($q_{u,v,\theta}$) for quantizing DCT transformation coefficients ($c_{u,v,b,\theta}$) produced by the DCT transformation. Watson also describes that a bisection method is used to increment or decrement a matrix, wherein the bisection method includes establishing a range for $q_{u,v,\theta}$ between lower and upper bounds, typically 1 to 255, a perceptual error matrix $p_{u,v,\theta}$ is then evaluated at midpoint of the range. Wallschlaeger describes that attenuation

values are scaled line integrals or scaled logarithms of the relative intensities. For the reasons set forth above, Claim 15 is submitted to be patentable over Smith in view of Watson and further in view of Wallschlaeger.

Claims 22-25 and 30 depend, directly or indirectly, from independent Claim 15. When the recitations of Claims 22-25 and 30 are considered in combination with the recitations of Claim 15, Applicants submit that dependent Claims 22-25 and 30 likewise are patentable over Smith in view of Watson and further in view of Wallschlaeger.

Claims 8-11 and 29 depend, directly or indirectly, from independent Claim 31 which recites a method for computing an approximation of a natural logarithm function including the steps of "partitioning a mantissa region between 1 and 2 into N equally spaced sub-regions; precomputing a reference point a_i of each of the N equally spaced sub-regions, where $i = 0,\ldots,N-1$; selecting N sufficiently large so that, for each sub-region, a first degree polynomial in m computes $\log(m)$ to within a preselected degree of accuracy for any m within the sub-region, where m is a binary mantissa of a binary floating point representation of a variable x; computing a value of $\log(x)$ for a binary floating point representation of x stored in a memory of a computing device utilizing the first degree polynomial in the binary mantissa m, wherein $\log(x)$ is a function of a distance between the reference point a_i and the binary mantissa m; and generating an image by using the computed value of $\log(x)$."

None of Smith, Watson, and Wallschlaeger, considered alone or in combination, describe or suggest a method for computing an approximation of a natural logarithm function including the steps of partitioning a mantissa region between 1 and 2 into N equally spaced sub-regions, precomputing a reference point a_i of each of the N equally spaced sub-regions, where $i = 0,\ldots,N-1$, selecting N sufficiently large so that, for each sub-region, a first degree polynomial in m computes $\log(m)$ to within a preselected degree of accuracy for any m within the sub-region, where m is a binary mantissa of a binary floating point

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representation of a variable x; computing a value of $\log(x)$ for a binary floating point representation of x stored in a memory of a computing device utilizing the first degree polynomial in the binary mantissa m, where $\log(x)$ is a function of a distance between the reference point a_i and the binary mantissa m, and generating an image by using the computed value of $\log(x)$.

Moreover, none of Smith, Watson, and Wallschlaeger, considered alone or in combination, describe or suggest computing a value of $\log(x)$ for a binary floating point representation of x stored in a memory of a computing device utilizing the first degree polynomial in the binary mantissa m, where $\log(x)$ is a function of a distance between the reference point a_i and the binary mantissa m. Rather, Smith describes that a close approximation to the logarithm is obtained by evaluating $\log(y)=-\log(a)+\log(1+(ay-1))$, that $\log(x)=k\log(2)+\log(y)$ and that mathematical identity $\log_p(x) = \log_p(2^k y) = (k+c_i)\log_p(2) - \log_p(b_i) + \log_p(1+(a_i y-1))$. Watson describes a method that includes the steps of transforming each color pixel, if necessary, into brightness and color channel values, down-sampling, if necessary, each color channel, partitioning each color channel into square blocks of contiguous pixels, applying a Discrete Cosine Transform (DCT) to each block in each color channel, selecting a DCT mask ($m_{u,v,b,\theta}$) for each block of pixels in each color channel, and selecting a quantization matrix ($q_{u,v,\theta}$) for quantizing DCT transformation coefficients ($c_{u,v,b,\theta}$) produced by the DCT transformation. Watson also describes that a bisection method is used to increment or decrement a matrix, where the bisection method includes establishing a range for $q_{u,v,\theta}$ between lower and upper bounds, typically 1 to 255, a perceptual error matrix $p_{u,v,\theta}$ is then evaluated at midpoint of the range. Wallschlaeger describes that attenuation values are scaled line integrals or scaled logarithms of the relative intensities. For the reasons set forth above, Claim 31 is submitted to be patentable over Smith in view of Watson and further in view of Wallschlaeger.

Claims 8-11 and 29 depend, directly or indirectly, from independent Claim 31. When the recitations of Claims 8-11 and 29 are considered in combination with the recitations of

Claim 31, Applicants submit that dependent Claims 8-11 and 29 likewise are patentable over Smith in view of Watson and further in view of Wallschlaeger.

For the reasons set forth above, Applicants respectfully request that the Section 103 rejections of Claims 8-11, 22-25, and 29-30 be withdrawn.

Claims 5-6, 13-14, 19-20, 27-28, and 32-35 are indicated as being allowable if amended to incorporate the recitations of the respective base claims and any respective intervening claims. Applicants thank the Examiner for the indication of allowable subject matter.

In view of the foregoing amendments and remarks, all the claims now active in this application are believed to be in condition for allowance. Reconsideration and favorable action is respectfully solicited.

Respectfully Submitted,

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